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COMPUTER SCIENCE MEETS AUTOMATION

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Preface

Dear Participants,

Confronted with the ever-increasing complexity of technical processes and the growing demands on their efficiency, security and flexibility, the scientific world needs to establish new methods of engineering design and new methods of systems operation. The factors likely to affect the design of the smart systems of the future will doubtless include the following:

- As computational costs decrease, it will be possible to apply more complex algorithms, even in real time. These algorithms will take into account system nonlinearities or provide online optimisation of the system's performance.
- New fields of application will be addressed. Interest is now being expressed, beyond that in "classical" technical systems and processes, in environmental systems or medical and bioengineering applications.
- The boundaries between software and hardware design are being eroded. New design methods will include co-design of software and hardware and even of sensor and actuator components.
- Automation will not only replace human operators but will assist, support and supervise humans so that their work is safe and even more effective.
- Networked systems or swarms will be crucial, requiring improvement of the communication within them and study of how their behaviour can be made globally consistent.
- The issues of security and safety, not only during the operation of systems but also in the course of their design, will continue to increase in importance.

The title "Computer Science meets Automation", borne by the 52nd International Scientific Colloquium (IWK) at the Technische Universität Ilmenau, Germany, expresses the desire of scientists and engineers to rise to these challenges, cooperating closely on innovative methods in the two disciplines of computer science and automation.

The IWK has a long tradition going back as far as 1953. In the years before 1989, a major function of the colloquium was to bring together scientists from both sides of the Iron Curtain. Naturally, bonds were also deepened between the countries from the East. Today, the objective of the colloquium is still to bring researchers together. They come from the eastern and western member states of the European Union, and, indeed, from all over the world. All who wish to share their ideas on the points where "Computer Science meets Automation" are addressed by this colloquium at the Technische Universität Ilmenau.

All the University's Faculties have joined forces to ensure that nothing is left out. Control engineering, information science, cybernetics, communication technology and systems engineering – for all of these and their applications (ranging from biological systems to heavy engineering), the issues are being covered.

Together with all the organizers I should like to thank you for your contributions to the conference, ensuring, as they do, a most interesting colloquium programme of an interdisciplinary nature.
I am looking forward to an inspiring colloquium. It promises to be a fine platform for you to present your research, to address new concepts and to meet colleagues in Ilmenau.

Professor Peter Scharff
Rector, TU Ilmenau

Professor Christoph Ament
Head of Organisation

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52nd Internationales Wissenschaftliches Kolloquium
Technische Universität Ilmenau
10 – 13 September 2007

S. Husung / G. Höhne / C. Weber

Efficient Use of Stereoscopic Projection for the Interactive Visualisation of Technical Products and Processes

Introduction

Today, product development dominates manufacturing time and cost, which are often also contradictory to high standards of quality. This is particularly a challenge for the development of micro-mechanical components and systems, where tight dimensional and form tolerances are important. The use of computer based tools enables the representation of product and process properties and supports their optimisation. One of the goals for the representation of the properties is the use of the *Virtual Reality* technology - a multimodal human-computer-interface with stereoscopic projection for spatial visualisation of 3D-objects. Therewith an immersion in the virtual scene becomes possible. Furthermore this enables an easy comprehension and understanding of complex contexts and relations, which are usually only evident for experts. By using intuitive interaction tools the user can navigate in the VR scene, manipulate and investigate the scene content.

VR system at Competence Centre “Virtual Reality”

In 2006 a new VR system was built at Competence Centre “Virtual Reality” at TU Ilmenau (Fig. 1). This is a flexible 3-side-projection system with the combination of stereoscopic projection and acoustic wave-field-synthesis [2] for creating a realistic sound impression in real-time along with the visualisation.
You can configure the system in three different setups, depending on the application, the size of the user group and the necessary immersion (Fig. 2). The setup with the highest immersion is the 90° CAVE-setup (Fig. 2a). Here the user can turn his head and always see the stereoscopic picture. But this setup is only good for one or two users because of the picture distortion. The two other setups enable an interdisciplinary discussion about the VR scene in larger groups. By using INFITEC [1], the system realises a full channel separation and supports a very good stereoscopic picture.

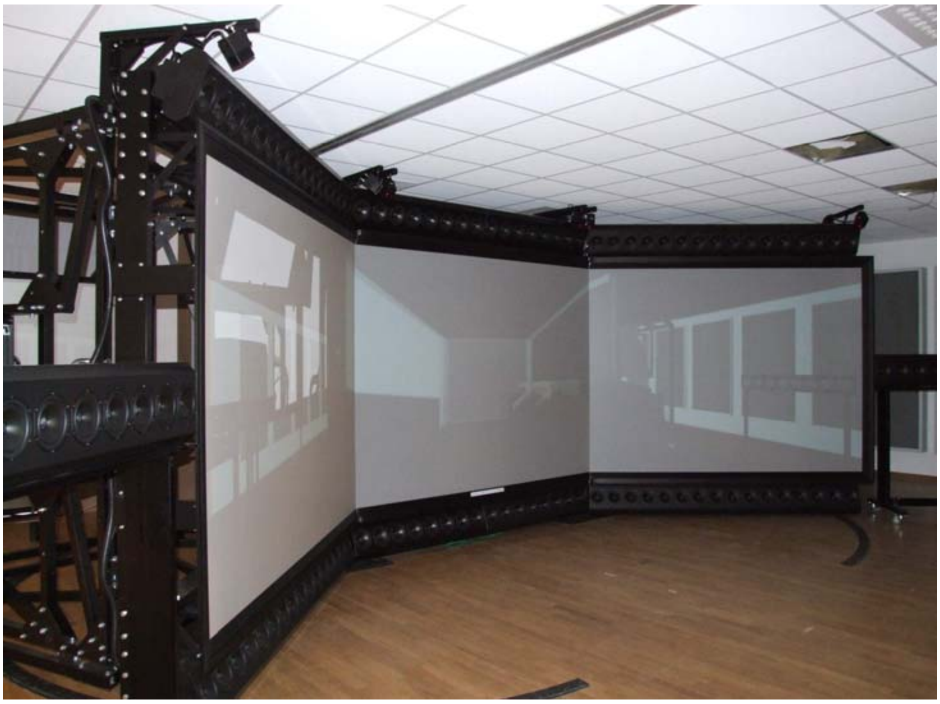

Figure 1. Audio-visual VR-system at Competence Centre Virtual Reality

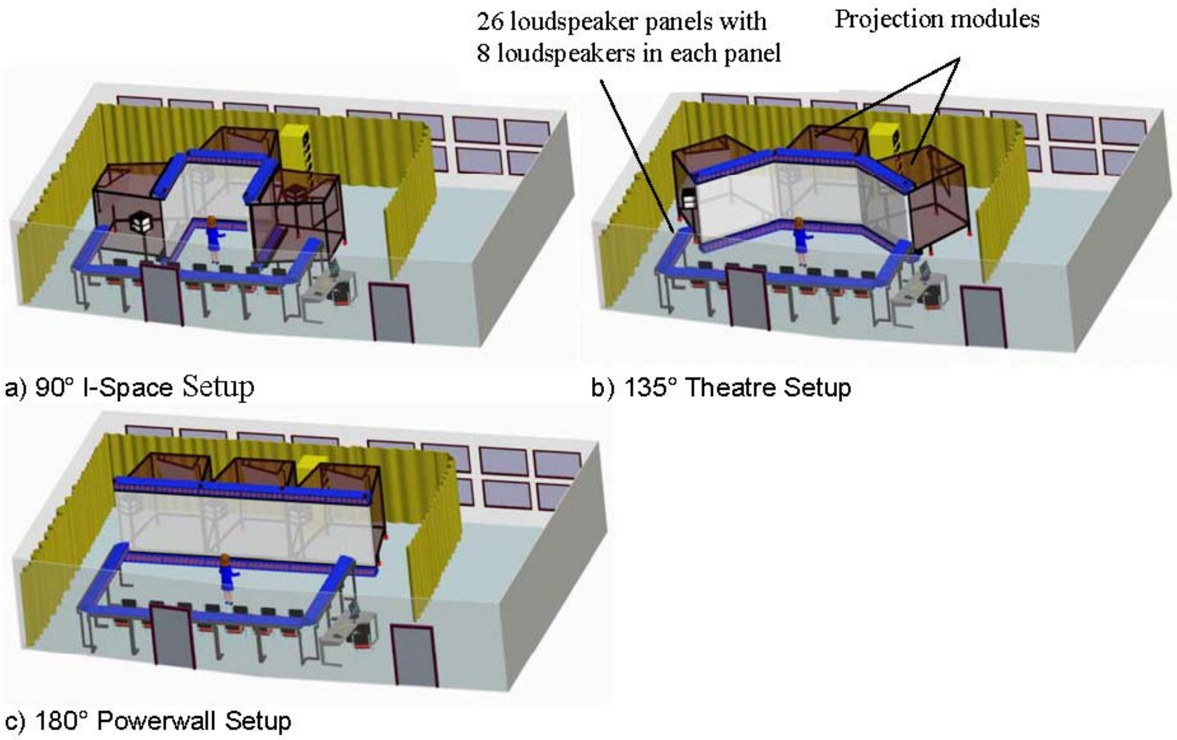

Figure 2. Setups of the flexible VR system

VR Applications

An important aim with the VR system is the assistance of several research areas for interactive visualisation of complex data. For example, there are many applications for product development [3]. They become particularly interesting when the virtual environment offers more than visualisation, e.g. the simulation of acoustic behaviour like in the installation at TU Ilmenau (see previous section).

In this contribution, however, another valuable application area is discussed: the interactive visualisation of measurement data, for example from the nano-measuring and nano-positioning machines which are the focus of other research activities of TU Ilmenau (Fig. 3). Here the aim is to get a VR model based on the measurement data automatically and quickly. For this several converters had to be developed.

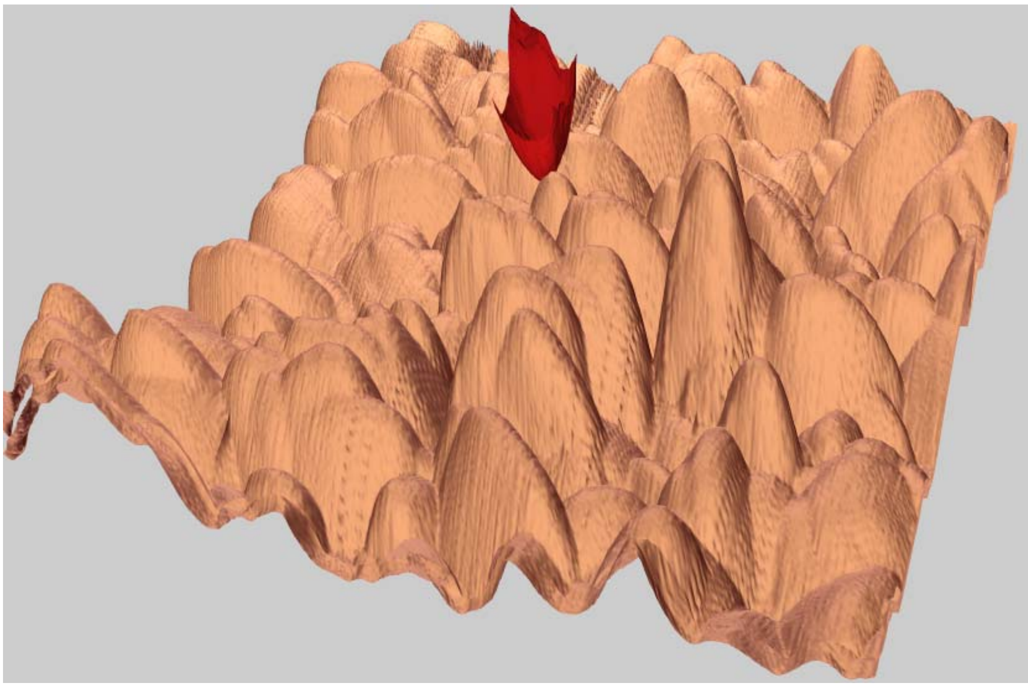

Figure 3. VR model of a measured nano-surface with a measuring tip

The measured data always has an array format with a determined edge length (see Fig.5 x_n and y_n). The content of each field is the value of the relative measured height. With this you have 3 coordinates defining each point, which can be used for the triangulation. By additional use of substitute colour representation the monoscopic depth information can be enhanced (Fig. 4). Because of the high resolution of the measured data and the accurate transfer to the VR model the generated representation is a good base for interdisciplinary discussion about the real surface. By using a scale over 10000:1 all details of the surface can be discussed efficiently.

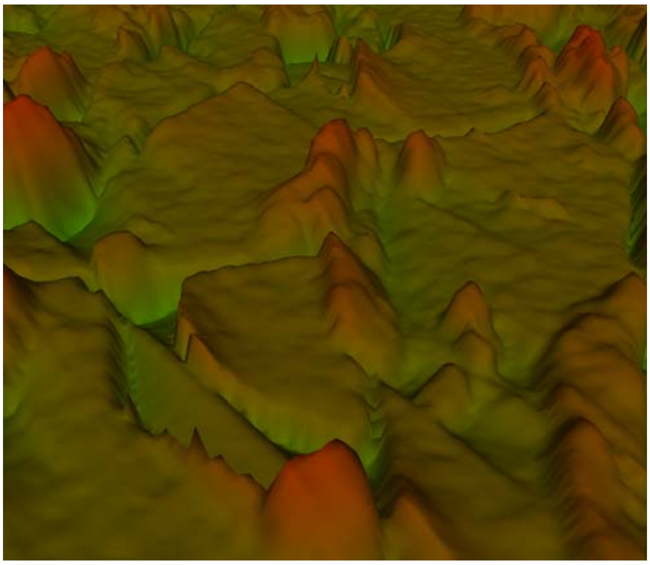

Figure 4. Coloured VR model of a measured nano-surface

In order to analyse the surface with people who do not know the measuring process, an animation of the process can support the understanding. So based on the known geometry of the measuring tip (Fig. 6) and the surface geometry an animation path can be created automatically. The animation path contains a key sequence and an appropriate transformation of the tip model.

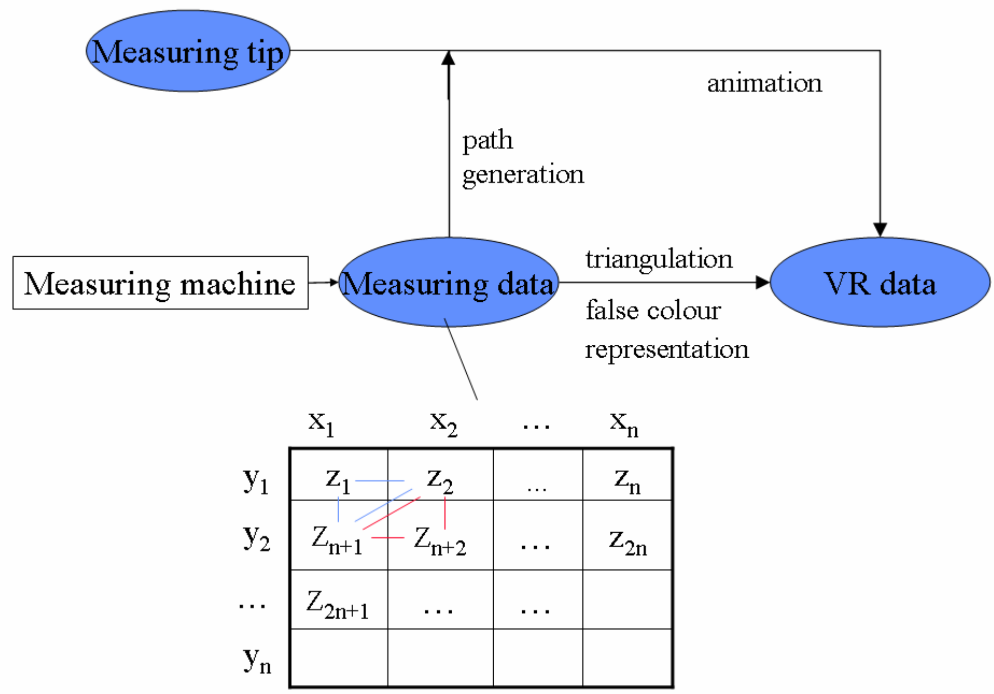

Figure 5. Method of VR data preparation based on measured data

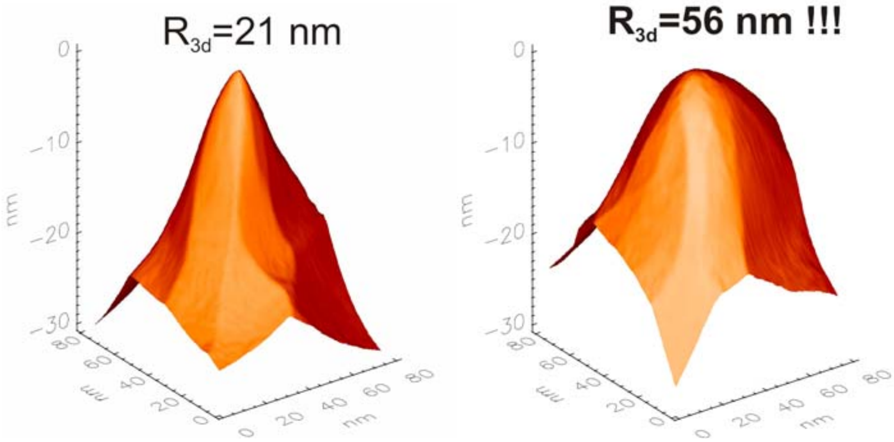

Figure 6. Cantilever tip before and after the use [4]

Conclusion

The technology Virtual Reality enhances the interdisciplinary discussion about complex contexts by stereoscopic visualisation and interactive manipulation of virtual scenarios of real objects with arbitrary magnification. Automatic converters reduce the expenses for data preparation and assist the integration of VR in other research areas. So VR becomes an important tool for several application areas as shown for Nanotechnology.

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